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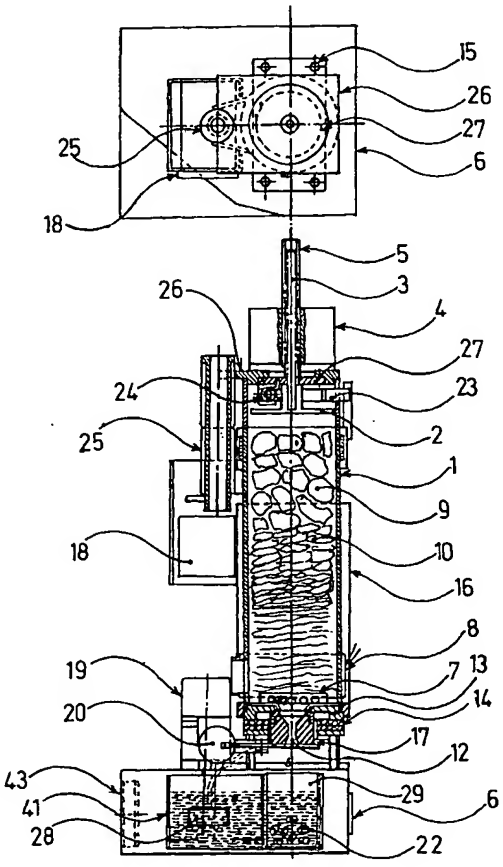
(54) Title: METHOD FOR DIRECT RECYCLING OF PLASTIC WASTES



(57) Abstract: The invention relates to a method and devices for direct recycling of post-consumer plastic wastes such as polystyrene cups, PET bottles, PE bags, agricultural films, etc, into intermediate or usable products. The devices are suitable for installation close to the source of wastes. In one embodiment, plastic wastes are fed at top of a barrel and pushed down to the heated bottom. The heat melts plastic components that extrude through a die at the bottom end of the barrel. This device can separate the components of plastic, by controlled increase in extrusion temperatures to more than melting points of each of the plastic components. Another device using the invention maintains a constant temperature profile along the length of a barrel. Multiple dies placed in different temperature zones extrude different plastic constituents, as the plastic wastes are pushed through zones of increasing temperatures. Extruded plastic can be cut in pellets, moulded, drawn as fibres or other forms.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD FOR DIRECT RECYCLING OF PLASTIC WASTES

FIELD OF INVENTION

This invention relates to a process and apparatus for local reprocessing mixed post-consumer thermoplastic wastes. Shopping bags, polystyrene foam, bubble film, PET bottles, other packaging materials and plastic articles presently constitute typically about 10 percent of solid wastes generated by urban and rural communities, in both developed and developing countries. The activity of plastic reprocessing presently involves multiple agencies; namely, collectors, segregators, balers, pelletizers, secondary manufacturers. This method is economically unaffordable for processing very cheap plastic wastes, due to which recycled plastics can often cost more than virgin materials. As a result, most plastic wastes are presently being incinerated or land-filled.

Presently, there are no machines for household or curbside reprocessing of post-consumer plastic wastes. If there were any local recycling devices for plastic wastes, they would certainly find favour with eco-conscious consumers, organizations and establishments, who might prefer to reprocess their own plastic wastes. Local reprocessing would enable individual wastes, such as polystyrene cups, PET bottles, PE bags, agricultural films, etc. to be reprocessed without getting contaminated by other wastes. This is important as repeated contamination of plastic wastes at several stages of collection and transportation is the main reason for the requirement of segregation and cleaning of plastic wastes. It would obviously be better in environmental and economic terms to reprocess plastic wastes as close as possible to their source, if a method can be evolved to achieve this end at low cost, without causing pollution by the recycling process.

The invention gives a process and apparatus suitable for direct conversion of mixed thermoplastic wastes to its saleable constituents in forms of plastic pellets, moulded articles or fibres. The machines can be affordably installed at or near all places of origination of plastic wastes. Household or curbside appliances based on the invention can work as "active litter-bins" to locally recycle lightly contaminated post-consumer plastic wastes.

DESCRIPTION OF THE PRIOR ART

Plastic raw materials are traditionally traded in form of pellets. Plastic wastes are also recycled into pellets or lumps, before converting into useful articles. Pelletization of plastic wastes involves processes of cleaning, sorting, shredding, pulverizing, density separation, and extrusion into pellets of uniform shapes. Conventional reprocessing industry uses large and expensive machinery for each of these purposes.

Mixing of different plastics is bane of reprocessing of post-consumer plastic wastes. For avoiding this process, US Patent No. 5,263,841 has described a device for household production of plastic blocks out of homogenized plastic wastes. However, such blocks of impure plastics have little or nil commercial value.

Segregation of plastic components is essential to produce commercial grade of recycled plastic. Presently, one or more of the following methods perform segregation:

1. Manual separation,
2. Separation of different plastics according to density variation. The medium for separation can be either air or water/liquid. Examples are cited in US Patent Nos. 05169005, 4409098
3. Separation by using differences in solubility of plastics in different solvents. Examples are cited in US Patent Nos. 4946940, 3553156
4. Separation based on differences in softening points and adhesive properties of different plastics at different temperatures. A process using this method is developed by Salyp N.V. and can be referred at -

   http://www.memagazine.org/backissues/april00/features/infrared/infrared.html
5. Separation by using x-rays or spectroscopic analysis of plastic articles to determine their compositions, and initiate their separation. Examples are cited in http://www.plasticrecycling.org/sort.htm

The above methods have following drawbacks:

1. Labour intensive, tedious and very costly method.
2. Error-prone methods as incompatible plastics also have similar densities.
3. Expensive solvents get contaminated and partially consumed. Disposal of process solvents adds to the pollution problem.
4. Expensive process. Cannot handle entanglements of wastes articles. Exposed heating of plastics cause their degradation by exposure to atmospheric Oxygen and volatilization.
5. Extremely capital-expensive method.

OBJECTS OF THE INVENTION:

The primary object of the present invention is to discover a simple and direct method for reprocessing mixed / unmixed post-consumer plastic wastes into usable pellets, moulded articles or fibres with use of simple technology and inexpensive machinery. This will enable reprocessing activity to be dispersed, rather than centralized. An immediate advantage of the technology would be to enable reprocessing of different types of plastic wastes by dedicated machines, located near the source of wastes or on curbsides. Many plastic wastes generated at homes or offices, such as carry-bags, Styrofoam, PET bottles, polystyrene beverage cups, etc. are quite pure at source, and would generate good recycled plastic if they are reprocessed without allowing their contamination.

However, it may be always not feasible to immediately reprocess different types of plastic wastes. With the best of intentions, other plastics can accidentally or inadvertently contaminate a "pure" batch. The next important object of the invention therefore is to produce a method for automatic segregation of plastic wastes from each other, and non-plastic contaminants like paper, glass, metal.

Plastics have to re-process in closed chambers for preventing their oxidation and volatilization, and also to avoid atmospheric pollution. It is necessary to add beneficiating ingredients, such as plasticisers, resins, pigments, and fillers, to the plastic batch to improve the properties of the

intermediate or final output. Fillers such as sand can increase density of pellets allowing safe disposition of the heavy pellets in water bodies or landfills, without risk of their floatation. Other additives add value to the plastic by improving workability, colour, working life, or other attributes. Thus the process and apparatus of the invention should anaerobically process plastics, and allow for mixing of additives.

DISCLOSURE OF INVENTION

A typical embodiment of the invention is shown in the accompanying figures and described in the following description. The components of the embodiment are identified as:

Figure 1 shows the section view of the preferred embodiment of the invention, which shows a low-cost vertical column cold-top extruder, designed for melting of typical household plastic wastes such as HDPE (milk) bags or PET (carbonated beverage) bottles.

Figure 2 to 4 show the post extrusion device options. The first option shown in figure 2 depicts a motorized scissors mechanism for cutting extruded plastic section into pellets that are immediately water-cooled and collected in a bin.

Figure 3 shows the second option in which molten plastic flows in an open compression mould placed below the machine. Simple solid articles like medallions, stoppers and nameplates can be moulded.

Figure 4 shows the third option of drawing the molten plastic in fibre form. Polymers like HDPE, PET are easy to draw as continuous fibres. Good regulation of die temperature and extrusion pressure can produce reasonably good fibres that can be bunched, woven or knitted to produce useful plastic articles like ropes, woven belts, scrubbers, door mats, etc.

Figure 5 shows a scaled up embodiment of the invention designed for simultaneous segregated output of different plastic components from a mixed batch of plastic wastes. Non-melting contaminants are also continuously separated. This machine can work effectively as a curbside

"active litter-bin".

DESCRIPTION OF FIGURES

Figure 1 shows the base stand 6 supporting tubular body 1 which holds the plastic wastes. Body 1 has hinge pin 25 rotatably carry lid 26. Latch spring 24 latches lid 26 concentric to body 1 with latch 23. Lid 26 carries pressing motor 4 having internally threaded hollow rotor shaft 5. The motor turns shaft 5 to move lead screw 3 up or down along with pressure plate 2. An internal keyway in lead screw 3 engages with an inward projecting stub of anti-rotation plate 27 to prevent rotation of screw 3 with shaft 5. In its lowest position, pressure plate 2 is approximately midway in body 1.

Electrical heater 8 banded around cylinder body 1 heats and melts plastic wastes 11occupying the lowest level inside body 1. Pressure plate 2 never descends to this level, thus ensuring its freedom to slide within body 1 without getting jammed by resolidified molten plastic between its sides and body 1. flowing up its sides. The pressure plate connects to unmolten plastic wastes 9 in the top zone. Under this layer lies the middle zone of semi-molten plastics 10 at a temperature between deflection temperature and melting temperature of the major plastic components of the batch. The temperature of the lowest zone 3 is maintained equal to or slightly higher than the melting temperature of plastic that is to be extruded. This temperature can be progressively increased to extrude different plastic components progressively according to their melting / softening temperatures. The solid, semi-solid and liquefied plastic mass behaves as a non-Newtonian fluid, transferring pressure from the pressure plate downwards, with a continuous drop in pressure due to friction of side-walls. The molten plastic extrudes from the nozzle at bottom center of the body with this pressure and its own weight. A metal sieve 7 resting on top of bottom plate 13 filters non-molten plastic or non-plastic components from the plastic melt before reaching nozzle 38. A screw jack assembly installed on base stand 6 of body 1 lifts the bottom plate though insulation boards 14. Jack bolts 15 in a push plate press against base stand 6 to lift the insulation boards 14. This seals the periphery of bottom plate 13 against the machined face in

the recess of pipe of body 1, preventing leakages. Extrusion die 12 is fitted to nozzle 38. Lower part of body 1, heater 8, and top portion of base stand 6 are all collectively insulated with ceramic wool insulation 16.

Figure 2 shows the motorized scissor mechanism in details. Pellet cutter motor 19 fixed on base stand 6 drives a double-faced cam 20. Each face of cam operates one of the scissor blades 21 that together cut the extruded strand into pellets 22. Bin 29 placed in water tub 41 under die 12 accumulates pellets and further cools them in water. Perforations in the bin allow flow of water to and from water tub 41, while automatically draining the water when removing the bin. Water-cooling of pellets 22 prevent them from adhering to each other and other metallic parts. The cutter motor 19 base suspends a water pump 28 inside the water tub. The water pump lifts water from the tub and pours it on the extruded plastic strand to form a solid crust and facilitate cutting. The warm water flows into the bin and back to the tub. Water tub 41 is rotated around column 33 for removing bin 29 out of the base 6 for removal of pellets.

Different plastic wastes such as polythene bags and PET beverage bottles soften and extrude from the die at different temperatures between 130 deg. C and 190 deg. C respectively, as measured in the die. Unlike metals, plastics have no real "melting points". The stated melting points are indicate of the temperatures at which the plastics lose almost all their viscosity and become free-flowing out of small holes such as in die 12. The molten plastic cools by about 20 degrees while traversing the distance between heater 8 clamped around the lower part of body 1 and die 12. Due to this cooling, the plastic exits the die in semi-molten condition.

The RTD measures the temperature in centre of the die and the electronic temperature controller maintains it to the required set point. Polymer components like polyolefins have lowest melting points and are extruded at low temperatures. The differences in melting temperatures, or more correctly the melt-flow characteristics, help in separation of plastics by using the principle of fractional melting. With gradual increase in temperature of the melting zone, different plastic ingredients such as Polystyrene, Polypropylene, polyester, PET, etc get drained sequentially

from the same die.

Figure 3 shows a different option of a split mould capable of directly hand-moulding recycled plastic in forms of small useful articles such as buttons, badges, name plates, etc. PET plastic waste can be moulded to make pre-forms suitable for stretch blow-moulding of the same articles as before.

For moulding purpose, plastic is extruded at higher temperature than for forming pellets. Motorized gate plate 47 plugs the die till the mould is ready to receive the melt. On opening the gate, the mould gets filled with molten plastic that fills up the mould cavity to the desired level. The gate plate then plugs the die and the filled mould is closed, and allowed to cool. The moulded article is removed by opening the mould and the cycle is repeated.

Figure 4 shows another option to directly convert recycled plastic to fibres. The extruded plastic strand is guided through and cooled by a ring-cooling die 44. The strand is solidified before it reaches the bin where it turns around a fixed idler roller 46 to reach another idler mounted on dancing roller 42. The diameter of the strand and pulling speed is decided by many factors including the plastic composition, temperature of extrusion die, the pull on the fibre exerted by weight of the dancing roller, and the pattern of cooling. Steady conditions of temperature and cooling result in a fairly uniform size and output of fibre. The fibre is wound around a motorized bobbin 45. The motor driving the bobbin wraps the fibre as it accumulates under the dancing roller, with the motor starting when the dancing roller reaches the bottom, and stopping when it reaches the top. This allows production of long lengths of plastic fibres that can be used for making various stranded, knitted and woven articles such as cleaning mops, doormats, wire ropes, belts, multifilament ropes, etc.

Figure 5 shows another embodiment of the invention suitable for curbside operations. This machine is designed to handle heavily mixed plastic wastes. It is designed to continuously separate the components of the waste by using a process of fractional melting, in principle akin to the more commonly known process of fractional distillation. The main body of this machine is placed horizontally and citizens deposit plastic wastes

in an overhead hopper at one end. A reciprocating electrically / pneumatically / hydraulically operated actuator 30 is movable at one end of body. The pressure plate joined to the actuator normally presses plastic wastes into the cylinder body while pressing forward. Intermittently, the pressing plate is retracted to admit plastic wastes from the hopper 36 into the cylinder body 1. The cylinder body has a series of nozzles at various points along the centerline, placed between heaters, optional air-blowers and RTD sensors, for maintaining the desired temperature profile across the length of the different zones. Plastic wastes are progressively heated as they pass each zone marked I to IV, and different components of plastic melt and extrude out of different dies fitted in the nozzles according to their order of melting. A second pneumatic / hydraulic / electromechanical actuator exerts controlled amount of backpressure on the counter-pressure plate 48 pressing against the open end of body 1. Non-melting residual wastes, including paper, plastic, stones, etc are discharged into the last collection chamber 40 D by lifting the plate 48. This discharge is suitable only for landfilling. The other collection chambers collect different plastics that extrude at different temperatures. Scissors mechanisms or other post-processing options as above are located under each die .

It is beneficial to have an increasing cross-section of cylinder body along direction of travel of the plastic mass to prevent clogging.

In a variation of the last embodiment of the invention, the body can be placed at an inclination to the horizontal layout described in figure 5; to derive benefits of gravity assisted forward flow of plastic.

BEST MODES FOR CARRYING OUT THE INVENTION

For best results, it is always preferred to process a single type of plastic generated from a single process or product usage, in a recycling machine built according to the first embodiment of the invention. For example, a dedicated machine can be used in conjunction with a coffee vending machine for recycling used coffee cups made from polystyrene. Special features can be provided to clean plastic wastes from known contaminants prior to recycling. In the above example of coffee cups, the likely impurities are beverage residues. Specific provision of rinsing and air drying of the plastic wastes before reprocessing would help to

improve the quality of output of dedicated machines.

The last described embodiment of the invention is very useful for kerbsides, drop-boxes, offices, eating places, etc. where mixing of plastic wastes would be the rule. In such places, the machine has to continuously segregate the different plastic components to get reasonable throughput in fully automatic operations.

Other embodiments of the machines can have "reverse vending" features to reward the usage of the machine.

The simplest embodiments of the invention can do without automation, and have the heater as the sole active electrical component. Pressure is applied by a ballast on top of the column of plastic wastes. The ballast is lifted by hand or foot to load fresh plastic into the machine. The extruded plastic is collected in form of lumps.

The embodiment described in figure 1 has an intermediate level of automation. It has a pressing motor, programmable temperature controller, pellet cutting device, water pump, exhaust fan and electrical interlocks. It also has a provision for removing non-melting contaminants from the melting chamber. Heater 8 of the embodiment is switched ON and OFF through the temperature controller operating around the set temperature. Low temperature plastics like LDPE melt at lowest temperatures, and extrude at temperatures as low as 120 deg. C measured near the die. High temperature plastics like PET / nylon melt at much higher temperatures and extrude from the same die only after the temperature is raised.

Anaerobic melting and internal scrubbing of gases is the special feature of the invention. The cold solid mass of plastic column in top zone of body 1 and lukewarm mass of deformed, compressed and semi-molten plastic in the middle zone of body 1 act as sealant. These plastics recondense the volatile gases emitted from the molten plastic, and they also prevent atmospheric Oxygen from oxidizing the molten resins. A suction fan creates a negative pressure in the region of extrusion die, water tub and top of the body 1 to further ensure that the very small quantity of gas emissions are evacuated from a single point, allowing

appropriate gas treatment appliances like scrubbers can be installed to clean the eventual exhausts from any source of air pollution. Cooling of plastic extrusion within the long die, and immediate crust formation due to direct contact with water prevents oxidation and gas emissions from the extrusion.

In the preferred embodiment, non-melting impurities remain in the body as they do not melt at even the highest temperatures that the device can achieve. These are periodically removed by opening the bottom plate at the bottom of the body 1 with help of jack bolts15. Without the bottom plate in place, body 1 is a through pipe and easy to clean with the heaters melting the plastic residues sticking to the inner sides of the cylinder body.

OTHER MODES FOR CARRYING OUT THE INVENTION

Other embodiments of the invention can differ in construction from the preferred embodiment due to differences in capacity, application, cost and features beyond the essentials.

It is beneficial to "knead" plastic wastes in zones 1 and 2, for which one method would be to use two pressing plates each driven separately by its own screw mechanism. While feeding plastic wastes, both plates are retracted completely. However, while applying pressure, the two plates move alternately to cause kneading of the plastics in zones 1 and 2. This will help to extrude the lower temperature plastics, trapped within mass of higher temperature plastics, out of the die before the latter.

An embodiment of the invention has a screw feeder automatically dispenses specific additives to the plastic batch at one or more stages of passage through the machine from hopper to the extrusion die.

INDUSTRIAL APPLICABILITY

The scope of the invention is not limited by the described embodiments, but includes all plastic melters / extruders in which plastic wastes are intermittently admitted at one end of a closed cavity and pressed towards

other end by a pressure plate which always connects to unmolten plastic at the feeding end while molten plastic extrudes from the other end. A temperature gradient in the cavity causes plastic to heat and melt as it progressively travels in the cavity. Liquefied constituents of plastic drain through one or more extrusion dies, located in different temperature zones. Additional heaters are used to condition the plastic leaving the die for ease of its post-processing such as cutting into pellets or drawing into fibres. The invention allows fractional melting of plastics with or without the facility of melt - separation of its different constituents.

It would be obvious to one conversant with the art that there could be different constructions and forms of machines that could perform and benefit from the invention. One embodiment of the invention employs devices and instrumentation to measure and control the rate of plastic melt flowing out of the die. Another embodiment uses a combination of heating and cooling with air or water to control the zone temperatures to higher accuracy.

The extrusion dies can be heated and / or cooled in controlled manner to regulate or stop extrusion from any die. The overall scope of the invention is therefore limited only by the following claims.

CLAIMS

What is claimed is:

1. A process and device for direct recycling of plastic wastes with at least one tubular body, at least one movable pressure plate, at least one extrusion die, at least one heater, characterized by;

- means for feeding said plastic wastes from one feeding end of said tubular body,
- said pressure plate means for pushing said plastic wastes away from said feeding end;
- said heater means for heating the tubular body in controlled manner to form a temperature gradient with at least three zones comprising a first zone at low temperature carrying unmolten plastic wastes encompassing the length of travel of said pressure plate, a second zone of semi-molten plastic, and third and subsequent zones of molten plastic in which at least one constituent of said plastic wastes is molten and extrudable out of the body through said extrusion dies.

2. A process and device for direct recycling of plastic wastes as in claim 1, with means of cooling and cutting said extruded plastic to form of pellets.

3. A process and device for direct recycling of plastic wastes as in claim 1, with means of cooling and pulling said extruded plastic in form of fibre strands.

4. A process and device for direct recycling of plastic wastes as in claim 1, with more than three of said zones, said heater means maintaining different temperatures in each of said third and subsequent zones to progressively melt more and more types of plastics to extrude different compositions of plastic constituents from different of said extrusion dies located in different temperature zones.

5. A process and device for direct recycling of plastic wastes as in

claim 1, with said tubular body placed in one of vertical and inclined orientations, said pressure plate being on top.

6. A process and device for direct recycling of plastic wastes as in claim 1, with said tubular body placed in one of horizontal and inclined orientations with said pressure plate being at one end, a feeding chute for holding plastic wastes over the tubular body over the feeding end, said pressure plate for intermittently retracting to admit plastic wastes from the chute into said feeding end.

7. A process and device for direct recycling of plastic wastes as in claim 1, with one of suction and ventilation devices for taking out vapors generated by heating and melting of said plastic wastes in said tubular device.

8. A process and device for direct recycling of plastic wastes as in claim 1, with means at said feeding end for washing and drying said plastic wastes.

9. A process and device for direct recycling of plastic wastes as in claim 1, with means at said feeding end for cutting said plastic wastes into smaller pieces.

10. A process and device for direct recycling of plastic wastes as in claim 1, with generally increasing cross section of said tubular body along the length of travel of plastic.

11. A process and device for direct recycling of plastic wastes as in claim 1, with means at said feeding end of adding additives and fillers to plastic wastes.

12. A process and device for direct recycling of plastic wastes as in claim 1, with means for injecting additives and fillers to plastic wastes in said tubular body.

13. A process and device for direct recycling of plastic wastes as in claim 1, with temperature controlling means for at least one of said zones.

14. A process and device for direct recycling of plastic wastes as in claim 1, with suction, piston or screw means to assist extrusion from said extrusion dies.

15. A process and device for direct recycling of plastic wastes as in claim 1, with one of molding, calendaring, drawing or blowing means to reform said plastic as it extrudes out of said die.

16. A process and device for direct recycling of plastic wastes as in claim 1 with a plurality of said movable pressure plates.

AMENDED CLAIMS

[received by the International Bureau on 17 February 2002 (17.02.02);
original claims 1-16 replaced by amended claims 1-11 (2 pages)]

1. A process and device for direct recycling of mixed and contaminated plastic wastes, characterized by;
   - at least one tubular body with means for admitting mixed and contaminated plastic wastes from an opening at or close to one end called feeding end of the tubular body,
   - at least one reciprocating member reciprocally movable within predetermined distance from the feeding end of the tubular body for pushing the plastic wastes from said feeding end towards somewhere in middle of said tubular body,
   - at least one heating element joining said tubular body beyond said predetermined distance from said feeding end for heating and melting at least one component of said plastic wastes within the body,
   - at least one orifice on said tubular body located beyond said predetermined distance from said feeding end facilitating outflow of molten components of said plastic wastes from said tubular body,
   - a gated opening at furthest end of said tubular body opposite to said feeding end facilitating discharge of other than said molten components of mixed and contaminated plastic wastes.

2. A process and device for direct recycling of mixed and contaminated plastic wastes as in claim 1 with at least two of said heating elements successively heating portions of said tubular body to higher temperatures, at least two of said orifices with at least one each of said orifices placed within or immediately following one each of said portions, and at least one likely constituent of said mixed plastic wastes unmolten at the lower temperature in the first portion melting at the higher temperature in the second portion.

3. A process and device for direct recycling of mixed and contaminated plastic wastes as in claim 1, said tubular body placed in vertical or substantially inclined orientation, said reciprocating member being fully retractable from said tubular body for feeding of plastic wastes through the top end of said tubular body.

4. A process and device for direct recycling of mixed and contaminated plastic wastes as in claim 1, with said tubular body placed in horizontal or substantially horizontal orientation, said means for admitting mixed and contaminated plastic wastes comprising a

feeding chute attached to the top side at feeding end of said tubular body, admission of plastic wastes from said feeding chute into said tubular body facilitating by retraction of said reciprocating member beyond said feeding chute, advancement of said reciprocating member for initially closing said chute before pushing the column of admitted plastic wastes away from the feeding end.

5. A process and device for direct recycling of mixed and contaminated plastic wastes as in claim 1, with ventilation apparatus for exhausting and neutralizing vapors generated by heating and melting of said plastic wastes from said tubular body.

6. A process and device for direct recycling of mixed and contaminated plastic wastes as in claim 1, with said feeding means comprising means for feeding washed and dried plastic wastes in said tubular body.

7. A process and device for direct recycling of mixed and contaminated plastic wastes as in claim 1, with said feeding means comprising means for feeding pulverized plastic wastes in said tubular body.

8. A process and device for direct recycling of mixed and contaminated plastic wastes as in claim 1, with said tubular body having a generally increasing cross-section from feeding end to opposite end.

9. A process and device for direct recycling of mixed and contaminated plastic wastes as in claim 1, with said feeding means comprising means for feeding at least one additive generally in proportion to the admitted plastic wastes.

10. A process and device for direct recycling of mixed and contaminated plastic wastes as in claim 1, with said gated opening capable of intermittently discharging other than the molten components of mixed and contaminated plastic wastes by manual operation.

11. A process and device for direct recycling of mixed and contaminated plastic wastes as in claim 1, with said gated opening automatically discharging other than the molten components of mixed and contaminated plastic wastes by transfer of pressure from said reciprocating member through accumulated unmolten plastics and other components within said tubular body.

STATEMENT UNDER ARTICLE 19 (1)

An important novel feature of the invention is the gated opening for discharge of solid / unmolten components of mixed and contaminated plastic wastes. Although this feature has been described in the specifications and illustrated in all figures, was not covered by the original principal claim. The principal claim is now amended to include this feature which apart from the orifice for extrusion of the molten components. The amendment distinguishes the invention from the prior art cited in the International Search Report.

Fig 1.

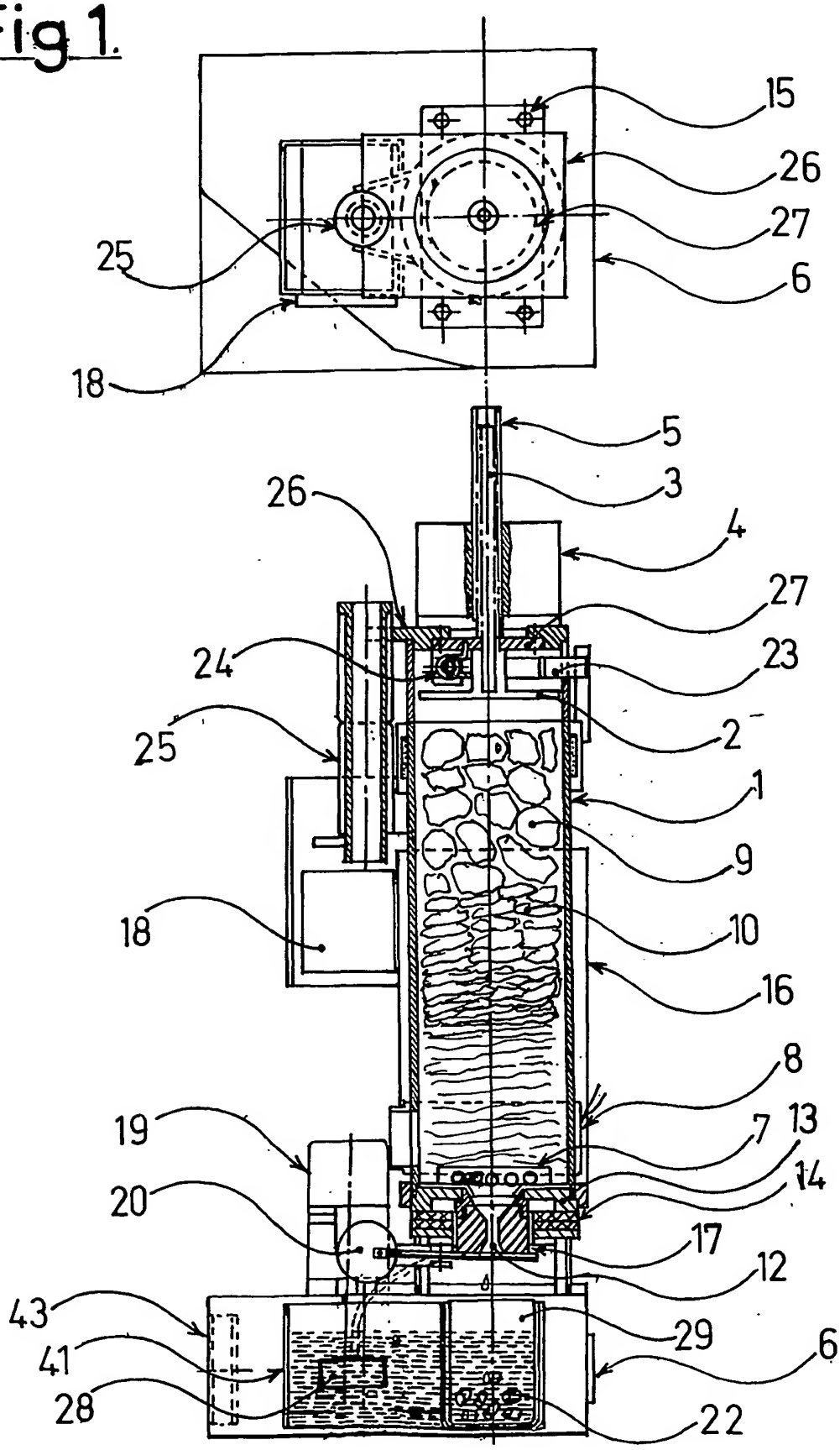
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Fig.2.

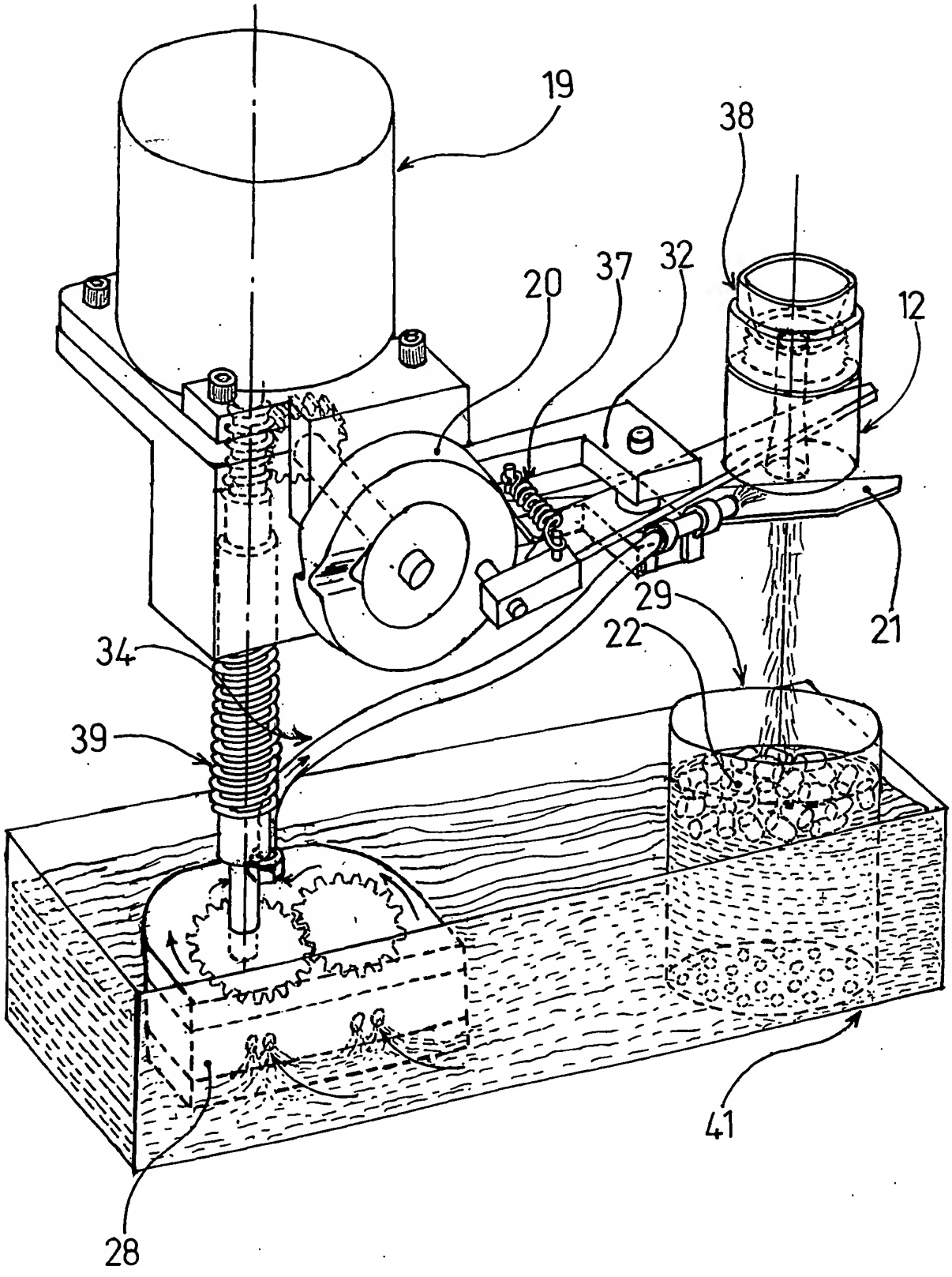


Fig. 3.

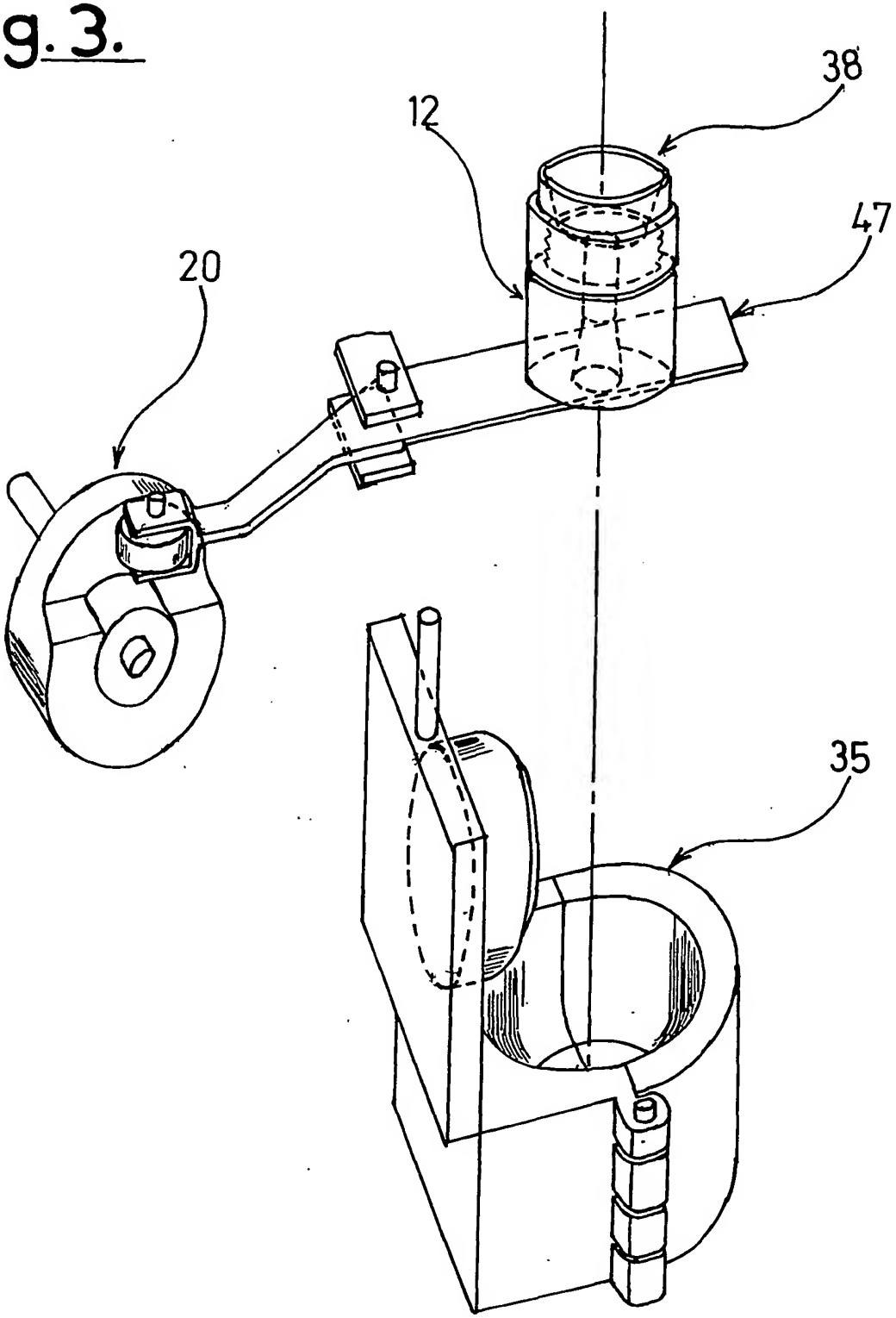
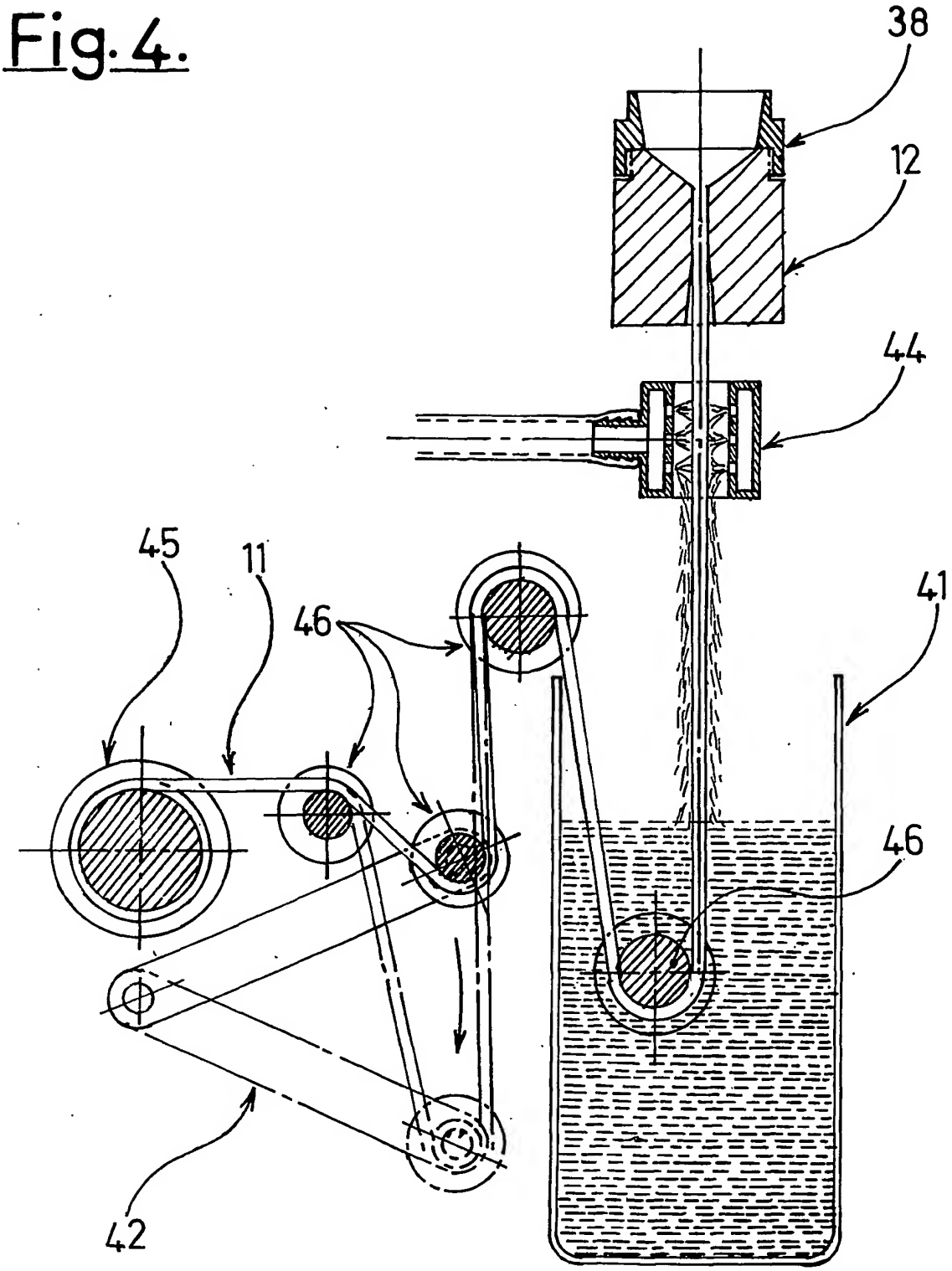


Fig. 4.



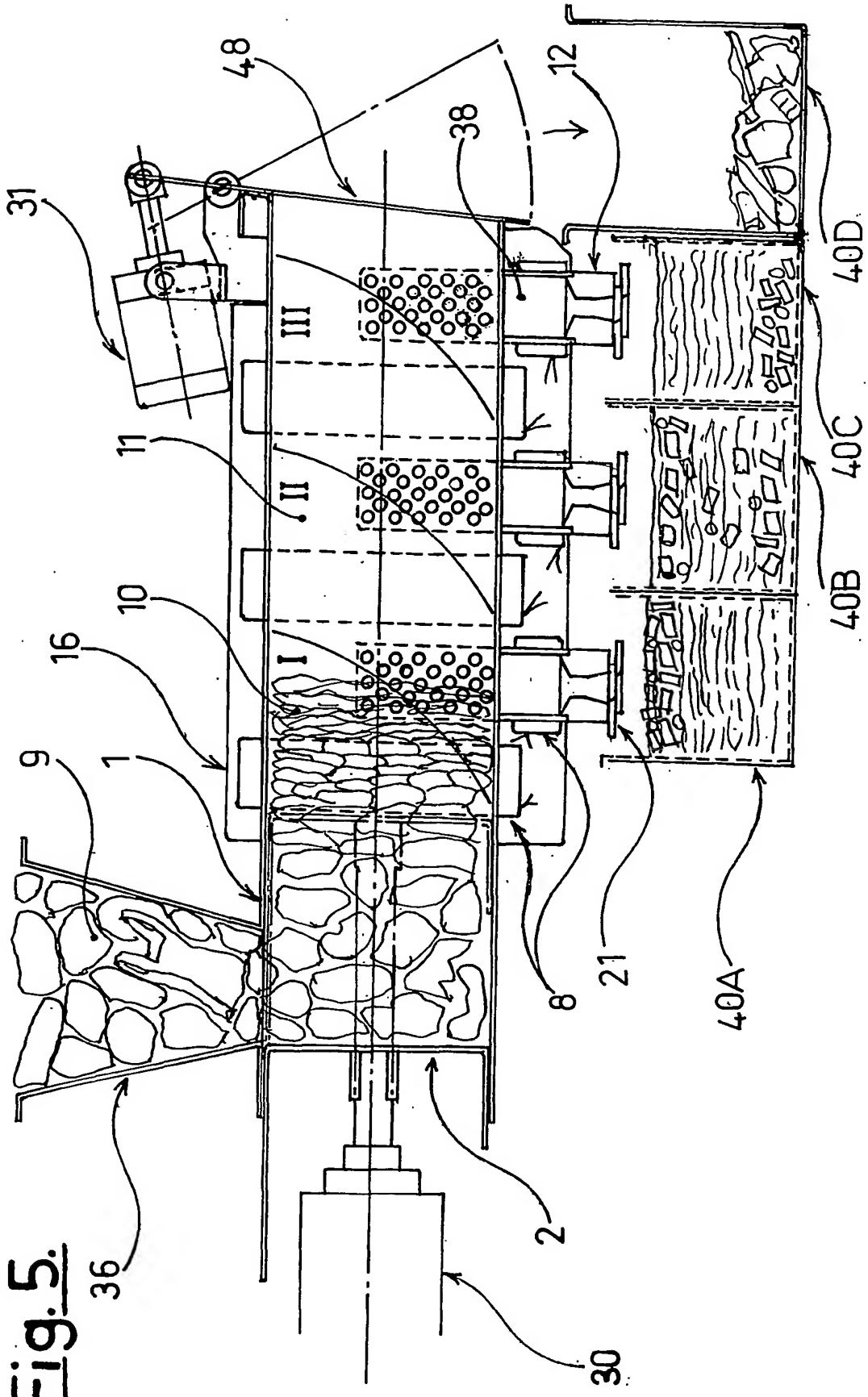


Fig.5.

INTERNATIONAL SEARCH REPORT

na Application No
PCT/[redacted]1/00096

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B03B9/06 B29B17/02 B29B9/06 B29B9/10 B29B13/02
B07B13/00 B03B1/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B03B B29B B07B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 4 162 880 A (COBBS WALTER H JR ET AL) 31 July 1979 (1979-07-31) column 5, line 46-62; claims 1,2,4,16; figures 2,1	1-3,5,6, 9,10 4,8, 11-16
Y	DE 28 37 621 A (HAEBERLE WILHELM) 10 April 1980 (1980-04-10) claim 1; figures 2,1	4,8, 13-15
Y	US 5 356 278 A (REETZ WILLIAM R) 18 October 1994 (1994-10-18) siehe Zusammenfassung "filler" figures 1-18	11,12,16

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
4 October 2001	22/10/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Kofoed, J

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C.(Continuation) DOCUMENTS CONSI[redacted] TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 013, no. 028 (M-788), 23 January 1989 (1989-01-23) & JP 63 242505 A (INUKAI SANGYO KK), 7 October 1988 (1988-10-07) abstract	1-3,7
X	US 3 205 533 A (RADY ROBERT R ET AL) 14 September 1965 (1965-09-14) figures 1,2	1-3
X	US 3 399 426 A (WEASEL JR GEORGE) 3 September 1968 (1968-09-03) figures 1-4	1-3
X	US 4 413 969 A (MCDONALD WILLIAM J) 8 November 1983 (1983-11-08) column 2, line 26-31; figure 1	1-3
A	US 5 240 656 A (SCHEERES DAVID J) 31 August 1993 (1993-08-31) claim 17; figure 8A	1-16

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